

MONTHLY JOURNAL OF  
THE MUSHROOM GROWERS'  
ASSOCIATION

# MGA

## BULLETIN

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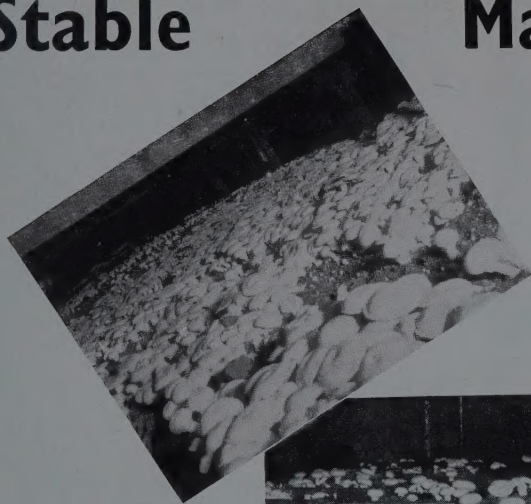
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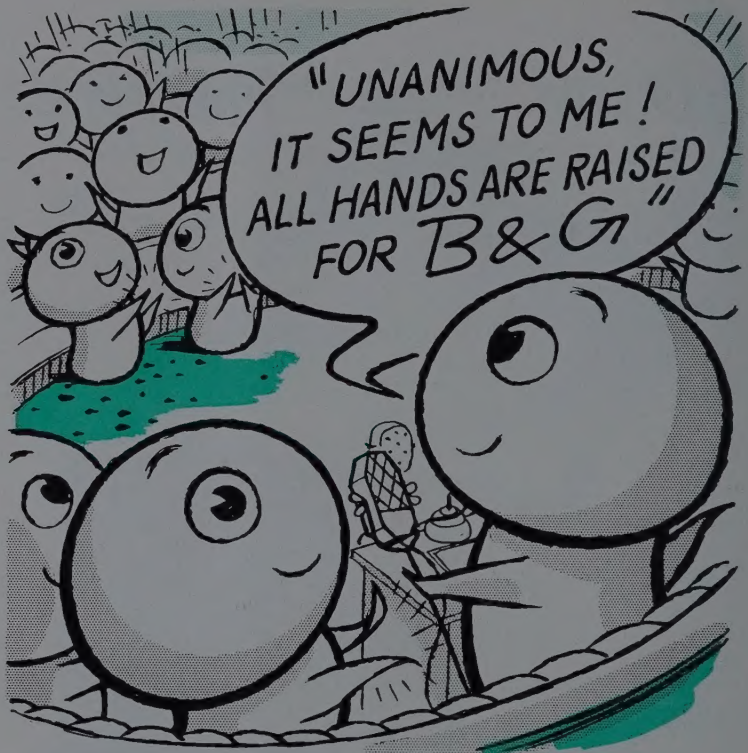
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**EDITORIAL**

## THE NEED IS DESPERATE

The recently announced steep increase in the price of coal, followed by an even steeper increase in the price of coke, is a matter which profoundly affects mushroom growers who, by their calling, use these products to a greater comparative degree than the rest of their unfortunates who are enmeshed in the horticultural industry.

It is a fortunate concern indeed which, faced with a rise in costs, can immediately transfer such increases direct to the general public and without delay. Doubly fortunate is the concern that can not only transfer the extra burden right away but can turn such events to advantage inasmuch as they are able, not only to cover the extra costs, but by raising the additional charge slightly, show a profit on the deal. Typical perhaps of the age in which we live is the fact that the end product—in this case coal and coke—is of far poorer quality than that obtainable many many years ago when competition in the pits made reasonable quality essential.

It is easy enough, in the dilemma which now faces the horticultural industry, to make sweeping charges against a nationalised industry and one fact which should never be lost sight of is that the miners, our fellow human beings, by their repeated demands for more and more wages and a continuance of the veto on restricted foreign labour, have much to answer for. But how many of us, similarly so placed, would put the national wellbeing before personal gain? A degree of selfishness is part of the human make-up, brought about by the absolute necessity to survive.

Further blows to the industry in general—one to mushroom growers in particular—are provided by the decision of the Agricultural Mortgage Corporation to increase the interest on all new loans to 5 per cent., and strangulation at birth of a credit scheme for horticulturists which saw the brief light of day in the nursery of the National Farmers' Union Development Corporation (Credit Service). Now comes the news that this pilot scheme, in which mushroom growers saw hope of obtaining much needed loans, has had to be shelved. Add to this the squeeze on existing bank overdrafts, ordered by the Chancellor of the Exchequer, and you have a somewhat sorry picture indeed.

It was said in my hearing the other day that any man connected with the production of fresh food was an utter fool in that, with existing Governments committed to a cheap food policy, there was no hope for the producer. Without doubt the speaker was referring to the horticultural industry in general since, for the main agricultural products, subsidies are made available although these are specifically designed to keep prices down and thus benefit the consumers.

No such subsidies exist for the horticultural industry in which mushroom growers are a part but it is to be hoped that the recent visit to the Minister of Agriculture by a NFU deputation, led by Sir James Turner, President of the NFU, and including Mr. E. H. Gardener and other leaders of the horticultural industry, will produce the results the deputation itself hoped for and the horticultural industry so desperately needs.

W.R.A.



### Mr. HARRY DAWSON

It is with regret that we record the death of Mr. Harry Dawson, Editor of the Broome & Greene Review and the Broome and Green Technical Review for nearly twenty years.

The late Mr. Dawson, who spent a lifetime in studying all aspects of technical publicity, had a very special place in the promotion of horticultural interests and his writings were widely read and highly esteemed. His unshakeable belief in the need for widespread and unified publicity for fruit and vegetables was well known and, throughout the industry, he will be much missed.

A good friend of the MGA, Mr. Dawson helped considerably with the planning of Bulletin No. 32, which was devoted solely to Heating, on which subject he was particularly well qualified.



### NFU DEPUTATION SEES MINISTER OF AGRICULTURE HORTICULTURAL PROBLEMS OUTLINED

A deputation of leaders of the horticultural industry, headed by Sir James Turner, President of the NFU, visited the Minister of Agriculture on Friday, 29th July, and outlined the difficulties facing the various sections of the horticultural industry, especially those created by the recent increase in the price of coal. The deputation put forward a number of proposals to deal with these difficulties.

The Minister afterwards thanked the deputation and promised that the representations made would be carefully considered.

In addition to Sir James Turner, the deputation included Messrs. E. H. Gardener (Chairman, Central Horticultural Committee), J. T. Sutton (Chairman, Glasshouse Produce Committee), E. J. Mount (Chairman, Flowers Committee), C. P. Norbury (Chairman, Fruit Committee), Col. L. R. Leach (Vice-Chairman, Glasshouse Produce Committee) and H. R. Haynes (Secretary).

## **ALL SET FOR THE ANNUAL EXHIBITION & A.G.M. AT BRIGHTON ON 5th & 6th OCTOBER**

All is now set for the Annual Mushroom Industry Exhibition at the Corn Exchange, Brighton, on 5th and 6th October, and, with the exhibition hall measuring over 170 ft. by 50 ft. and all the stand space already taken, Brighton 1955 may well create a record for this annual event.

Rightly so, the greatest possible interest is being taken in the visit for Dr. J. W. Sinden and Dr. E. Hauser from Gossau-Zurich, Switzerland, two of the best-known personalities in the Mushroom Industry throughout the entire world. Without any doubt whatsoever, the fact that both have promised, not only to attend the exhibition but to each give a lecture, is a real feather in the MGA's cap and it is quite certain that the period allocated to questions after each lecture will be eagerly taken up by growers.

Mrs. Hauser will lecture at 3.45 p.m. on Wednesday, 5th October, on "The Economics of Mushroom Growing in the Light of Recent Developments" and the following day, 6th October, at 10 a.m., Dr. Sinden will lecture, his subject being "Disease Control and Sanitation Programme for Mushroom Nurseries." The lectures take place in the concert hall adjoining the Corn Exchange. Growers will note with interest that each subject covers a very wide field and were chosen for this very reason, thus making sure that each would have the widest possible appeal.

The Exhibition opens each day from 10 a.m. to 7 p.m., with the general public being admitted on the second day only, thus leaving the first day to growers and others directly interested in the industry. At various times throughout the programme cooking demonstrations will be given.

A new innovation, an "eve of the show get-together," has been fixed for 9 p.m., on Tuesday, 4th October, at the Adelphi Hotel. Growers who intend spending that night in Brighton will find many friends there, anxious and willing to discuss anything connected with mushrooms. Next day a party of journalists representing national publications, are to be entertained, shown round the exhibition and, it is hoped, taken on a tour of a nearby mushroom farm. The reception by the Mayor of Brighton (Ald. J. A. Trevelyan Leak, J.P.) is at 8.30 p.m. that evening at the Royal Pavilion. On the second day the Chairman's (Capt. Lawrence) reception is at 12.30 p.m. at The Ship Hotel, followed by the Annual Luncheon at 1.30 p.m., which in turn is followed by the A.G.M., at 3 p.m., all in the same hotel.

This, the yearly focal point of the whole mushroom industry of this country, is **YOUR AFFAIR** and it is **VITAL** and **IMPORTANT**. Is it true that some shelf growers are getting nearly 8 lb. per sq. ft. on synthetics annually? Do you believe that some tray growers, turning out five or more crops a year, are obtaining 2 lb. per sq. ft. per crop? You can find the answers to these and many other questions at Brighton. **PLEASE COME.**

Support from the trade side of the industry has been really excellent for no less than 340 ft. of stand frontage representing over 4,000 sq. ft.

of stand space has been taken. Two machines will be demonstrating pre-packaging for mushrooms—a new departure for this exhibition and something of a peep into the future.

**Tuesday, 4th October:**

9 p.m.

**PROGRAMME**

MGA Members "meet," Adelphi Hotel—to talk mushrooms—dance—buy other members drinks.

**Wednesday, 5th October.**

10 a.m.—7 p.m.

Mushroom Industry Exhibition, Corn Exchange.

11 a.m.

Competition Judging.

3.30 p.m.

Competition Results.

3.45—5 p.m.

*Lecture:* DR. E. HAUSER.

8.30 p.m.

Mayor's Reception, Royal Pavilion. Presentation of cups.

**Thursday, 6th October:**

10 a.m.—7 p.m.

Mushroom Industry Exhibition (open to Public).

10 a.m.—11.30 a.m.

*Lecture:* DR. J. W. SINDEN.

12.30 p.m.

Chairman's Reception, The Ship Hotel.

1.30 p.m.

Annual Lunch, The Ship Hotel.

3 p.m.

Annual General Meeting, The Ship Hotel.

4.45 p.m.

Meeting of Executive Committee.

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## TWO NEW CUPS FOR COMPETITION

**G. W. BAKER** (*Chairman, Exhibition Sub-Committee*)

Once again the Annual Mushroom Industry Exhibition is drawing very near and I am glad to tell you that, with the addition of two new cups which are being kindly given this year, and the removal of the now somewhat outdated class for brown mushrooms, a handsome cup will this year be competed for in each of the seven classes on the schedule.

These two new cups, which have made this possible, are being given by Messrs. Broome & Green Ltd., and Messrs. Pask, Cornish & Smart Ltd., two very well-known firms of salesmen who regularly handle mushrooms.

The Broome & Green Cup is for Class 3 (2½ lb. White Cups) and the Smart Cup for Class 4 (2 lb. White Opens). This year, in all, there are seven cups to be won headed by the MGA Cup. The other cups are:—The Mount Cup, the Thwaites Cup, the T. J. Poupart Cup and last year's newcomer, The Stable Manures Cup. Miniature cups for every class will be presented, with the originals, by the Mayor of Brighton at his reception at 8.30 p.m. on 5th October, in the Royal Pavilion. Last year's miniatures too, will be presented at the same time.

As the great majority of members already know, the aim of the MGA is to make these competitions as wide open as possible and, with this end in view, all the cup competitions with the exception of the MGA Cup, can be competed for by members and non-members alike. None of the cups themselves can be won outright but the miniatures are the permanent possession of the winners.

Everyone connected with the organising of this annual exhibition is hoping that this year, at the Corn Exchange, Brighton, the competition for these trophies will be keener than ever. The full show schedules will be circulated to all members within the next few days. Non-members may have a copy on application to the MGA Secretary, 45 Bedford Square, London, W.C.1.



# MUST THEY ALWAYS BE

*Psalliota* spp.?

By M. D. AUSTIN

Recently, after giving a lecture on 'Commercial Mushroom Growing,' I was asked many questions, some of which raised points of considerable interest and importance. One of these concerned the probable future of commercial mushroom production and, in particular, the economics of this specialised crop.

Whilst there have been many authoritative and worthwhile publications in which the costings of various crops are considered, a modern and complete account of this aspect of mushroom growing would be of inestimable value to many. The full costings associated with this crop grown as a complete and full-time undertaking might indeed be illuminating. To-day, with the many complexities involved, a simplification, if such is possible, would render a service indeed.

A parallel account of the economic possibilities of the crop as a part-time venture also might be interesting.

In this latter connexion it sometimes appears that some production costs are 'hidden': when revealed they might show that for some the production is an excessively expensive business.

Guidance in this matter should be available to those who wish seriously to consider it, particularly in the initial formative stage of a career.

Another question, pointedly put to me, forms the basis of the following notes.

If the forward march of progress in any industrial field is not to be checked or completely arrested those responsible for the administration of its affairs must ever be on the lookout for new channels for development. These may include new methods of presenting well-known commodities to the public; a reduction in price made possible by a more economic production approach or, every now and then, an entirely new product to meet an existing need. Or even a new product creating a new need—publicity often performs this miracle! However, usually overshadowing all of these aspects is the most important one of extending the market by gaining new customers!

When more than one of the above aspects are employed together ultimate success is frequently more assured. Further we live in an age of 'change': in an age when 'change' is expected and often demanded.

If the above thesis has validity for industrial commodities it is equally so for the basic agricultural and horticultural way of life.

Instinctively recognising the truth inherent in the reaching out for new commodities, and the economic advantages in meeting the demand, Horticulture has seldom lagged behind. Indeed the history of the Fruit, Flower and Vegetable industry is land-marked with notable successes due to the introduction of 'new' species or varieties to the public. The leaders in this industry, undaunted by an initial conservative and cautious reception, have ever been prepared to experiment, to develop trends, create demands and, finally, to attempt to bring into every home the once 'new' species.

What does the mushroom industry offer to take a place in this unfolding pattern? Does it make its presence felt? Where are its experiments in the field of adventure? Its new species, its attractive variants? Must they always be *Psalliota* spp.?

Why not commercially grow some other edible fungi? Why not experiment on these lines and so to explore the possibilities and thus extend the range?

Is it not high time that the Mushroom industry conquered fresh fields?

With a *choice* of edible fungi the public might become more aware of the delights of fungal fare! Some gourmets already know.

Goodness knows how many species of fungi are habitually eaten: we know that in Japan and elsewhere the number is certainly not restricted to one alone.

A solitary product has no basis for comparison, no competitors: its selling value is thereby the poorer for this handicap.

The barrier due to an ignorance of the status of many fungi could only be removed by a progressive form of educating through publicity. Initially it might be important to attack the traditionally British inhibitions about fungi in general and publicise the safely edible range.

Many people do not care to sample even the well-known commercially grown mushroom because of an instinctive repulsion to the very name 'fungi.' Many more will ruthlessly behead any field growing fungi where they would leave untouched the nearby flower. Fungi and Frogs seem too closely akin to the Witch's Cauldron in the minds of these. However, these people do not reject the Blackberry because the Belladonna is a deadly plant: their balanced discrimination conditions their action here!

There are, however, many in this country who know and experience the culinary possibilities of quite a number of the so-called 'wild' edible fungi. This taste might well be extended to include a wider public.

The idea may seem startling: innovations are seldom less!

There may be quite rational objections to their commercial exploitations, but a consideration of those species of fungi listed as edible suggests that some experimentation is surely possible and may be worth while. Take as a starting point the fact that our well-known mushroom has only reached its lonely, and thus pre-eminent and seemingly unassailable position because of much improvement in the public's attitude towards it. I know some who now eat mushrooms whereas but a short time ago the thought of so doing filled them with apprehension!

If it is suggested that it would not only be difficult but well-nigh impossible to grow other species of fungi I would say surely the wit of man can wrest from Nature the several 'secrets' peculiar to some fungal habitats? Their mode of life, their nutrient needs, the condition best suited to their cultivation and their later commercial production.

Once, in the long ago, there must have been men willing to take a chance; these were the mushroom pioneers! Are there none now who would 'have a go'? Pioneers are not known as having 'cold feet'—they press on regardless!

In the Editorial of the June, 1955, issue of the MGA Bulletin it is truly remarked " . . . . . the eyes of almost the whole of the industry in this country are turned towards expansion and greater production." Why not more than a fleeting glance at the possibilities of a greater range of edible fungi production?

For instance could a future be made for the production of some ' new ' fungi to be dried or processed at source: for sale as flavourings: or for consumption as such? At least one—the Horn-of-Plenty—is said once to have been sold at Covent Garden!

Are there commercial possibilities in marketing ' new fungi '? Could pure culture spawn or what you will be readily produced?

Would it be a development to interest none but the connoisseur—or a larger public?

I expect there are many reasons why the idea should be still-born: there may be one which could keep it very much alive!

---

## THE FRED ATKINS ALPHABET U/V

**Underground.** There are several underground mushroom farms in Britain; the Godstone caves, those at Bradford-on-Avon, and Matthew Pinkerton's mines in Scotland spring to mind. There are hundreds more in France, where cave culture is almost universally practised. But the most famous underground plants are undoubtedly those operated in the United States by the Knaust Bros., whose annual output is around 13 million pounds.

**Under-composted.** Masses of *Coprinus* ink-caps and a high pH are indications that manure is under-composted and needs at least another turn. That doesn't mean to say the yield will be poor, but rather that the risk of failure is greater.

**Urea.** A chemical compound found in the urine of mammals. The percentage of nitrogen in " technical urea " is about 45, and the synthesized material is a comparatively inexpensive source of N for boosting strawy manure or as an ingredient in the MRA formula for synthetic compost.

**Variety.** Mycologically, variety is a sub-classification of species. Among growers it is a term used to differentiate between different-looking mushrooms, such as white, cream and brown varieties.

**Veil.** A partial *velum*, or veil, which protects the *lamellae*, or gills, of mushrooms and which later breaks to release the maturing spores, leaving a fragmentary *annulus*, or ring, some way up the *stipe*, or stalk.\*

**Ventilation.** Compost needs fresh air. During peak heat oxygen is essential. Growing mushrooms are stimulated to legginess and early opening in the absence of ventilation. There may be, in the absence of ventilation, a build-up of carbon dioxide, which discourages normal development of sporophores; but recently it has been suggested that another evil may be at work, and we have been invited to call it Gas X. For the moment, when in doubt, ventilate. Or turbulate. Or alternate, if you prefer. Not that I ever met a grower who wasn't alternating . . .

*Vert de Gris*. *Verdigris*. See Yellow Mould—if I every get that far!

**Vermiculite.** This material is produced by heating mica momentarily to temperatures between 600 and 900 ° C. In loose form it is an exceptionally good insulator. Mixed with peat it has been found by the Yaxley Research Station to make a useful casing; the magnesium content is unfortunately high, and this has discouraged its use.

**Vern Astley Disease.** This “mould infection of the compost, resulting in a distortion of the sporophores, accompanied by reduced production of mushrooms and severe respiratory troubles in the workmen emptying the house” is described by Sinden and Hauser in *Mushroom Science I*.

*Verticillium* spp. The cultivated mushroom is susceptible to attack by two species of *Verticillium*: *malthousei* and *psalliotae*. Both cause Brown Spot, longitudinal splitting of the stalk and hare-lipping of the cap, and may eventually stop production. Zineb is nowadays the usually prescribed control.

**Virus.** No one knows yet whether any mushroom disease is caused by a virus. There is, I think, no evidence that Mummy is due to a virus, as some suggest.

**Visitors.** I pass (and wish more of them would).

**Vitamins.** Report from Ohio has it that a combination of riboflavin, thiamine, pantothenic acid and niacin gave a total yield increase of 56·8 per cent. Reeve, in West Chicago, later found that calcium pantothenate, aneurin hydrochloride, pyridoxine hydrochloride, niacin and riboflavin, added singly or in combination, had no effect on growth or yield.

**Volatilisation.** When a solid changes directly into a gas without first becoming a liquid it is said to volatilise.

\*Technical terms, wherever possible, are explained for the benefit of former schoolmasters.

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## MUSHROOMS IN THE SURGERY

Under this heading the World Digest reports that from India comes the news that ordinary mushrooms contain an antibiotic. Dr. S. R. Bose, of Carmichael Medical College Hospital, Calcutta, fed this mushroom antibiotic to a patient with typhoid fever—with good results. He used the crude extract given by mouth and hypodermic injections.

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## EMIGRATING !

Reporting that a canning firm in New South Wales is paying children in Tasmania 1/- per lb. for wild mushrooms with stalks cut off at gill level, the “Sun-Herald” of Sydney, Australia adds:—“Even cultivated mushrooms cost up to 10/- lb. in Sidney—with long stalks.”



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# THE CULTIVATED MUSHROOM

## 14—Nutritive requirements

By ANDRÉ SARAZIN

### Organic substances

The cultivated mushroom is unable to build up the complex molecules which it requires for the manufacture of its living matter by any direct process from carbon and mineral nitrogen. It is obliged, in order to ensure its continued existence, to seek these substances in a more or less complex medium. Nevertheless, from among these diverse organic media it has made its choice, a choice with which it is of interest to us to become familiar in order to promote the formation of these necessary substances in the composts which are used in cultivation. Certain of these substances influence the rate of growth of the mycelium, others influence the fruiting potential; but as it has been already stated, the impossibility of obtaining carpophores in pure culture on a standard medium compels the investigator to search around empirically for the factors which stimulate fruiting. On the other hand, the rate of growth and total growth can be studied in pure culture, and the literature on these subjects is more abundant and more accurate.

### Carbohydrates

A very good review of the work done on the carbon nutrition of the cultivated mushroom is given in the important treatise by Treschow (1944). Its essential features are included in what follows.

Styer (1928, 1930) obtained good growth in pure culture, on filter paper impregnated with nutritive solution, with arabinose, glucose, maltose, and xylose; not such good growth with galactose; and no growth with mannite. He obtained good growth with pectic substances, hemicelluloses, humus compounds and lignins, but only slight growth with cellulose. However, Treschow criticised this work on the grounds that Styer used an unfavourable source of nitrogen, namely, ammonium nitrate, and no growth substances.

Still working with pure culture media, Treschow reached the following conclusions:—

As regards the monosaccharides investigated, the beneficial effect in order of priority was as follows: glucose, fructose, galactose.

As regards polysaccharides examined:—maltose, saccharose, inulin, and soluble starch and mannite.

As regards organic acid salts, good growth was obtained with calcium malate, calcium oxalate, much less with potassium tartrate, and very slight with sodium acetate. Good growth was obtained with pectins extracted from apples.

To sum up, the cultivated mushroom makes advantageous use of carbon compounds in the following order of priority:—xylose, arabinose, glucose, fructose, pectins from apples. Of a lower order are galactose, maltose and saccharose. Calcium malate and calcium oxalate have the same effect as glucose.

If now we turn to the natural culture media of the cultivated mushroom, amongst which horse manure still occupies priority, research workers have attempted to ascertain what substances the cultivated mushroom elects to use first and whether these are elaborated in sufficient quantity during the composting process. Treschow (1944) has written an historical account of this subject. Hebert and Heim (1911) observed that during composting there was a marked fall in the concentration of cellulose and xylan, and that later, during the growth of the cultivated mushroom in the compost, there was a marked fall in the concentration of cellulose and lignin and a relatively slighter fall in the concentration of xylan.

Since then two tendencies have become delineated:

The first, represented by Waksman and his co-workers (McGrath 1931, Nissen 1931, 1932 and Smith 1934), attaches great importance to lignins which nevertheless are not used until after the assimilation of the hemicelluloses. The second, which is represented by Kliouchnikova (1935), contradicts the first, contending that lignins are not attacked at all by the cultivated mushroom and that only the hemicelluloses are important as carbon sources. Cayley (1938) confirmed these conclusions micro-graphically. In sections, the parenchymatous cells of the straw are attacked by the mycelium while the woody particles which contain the lignin are attacked only after prolonged growth of the mycelium.

According to Treschow (1944), xylose and xylan are used up first and then the hemicelluloses are hydrolysed to xylose by special enzymes. This author found support in the fact that the best crops are obtained on composts based on wheat straw and that wheat straw is rich in xylan. Treschow considered that Waksman's theory was wrong and maintained that the aim in composting is, not to accumulate lignin, but proteins, getting rid of ammonia which is harmful. From all these results it would seem that, during the growth period of the cultivated mushroom, the first substances to be attacked are the hemicelluloses, then the celluloses, and finally, the lignins.

It is of course a matter of interest to ascertain what are the carbohydrate substances that the cultivated mushroom is likely to find in the compost, for example, xyloses and hemicelluloses which appear to be substances of choice.

The material which is the most important for and richest in carbohydrate substances is the straw component of the manure and, therefore, we must become familiar with microbial activities which are able to liberate such substances from the straw fibre or are capable of synthesizing them during the composting process.

Demolon and Burgevin (1941), according to G. Pichard, give the following composition for wheat straw harvested at Versailles in 1934:

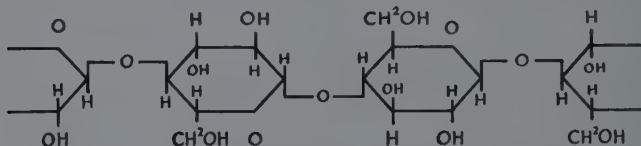
							Ble (Wheat) Garnett strain per cent.	Ble (Wheat) Vilmorin 27 strain per cent.
Lipids	..	..	..	..	..	..	1.95	2.00
Resins	..	..	..	..	..	..	4.90	7.05
Pectins	..	..	..	..	..	..	2.15	6.05
Pentosans	..	..	..	..	..	..	26.15	27.5
Hexosans	..	..	..	..	..	..	9.05	1.70
Cellulose	..	..	..	..	..	..	25.90	26.50
Lignin	..	..	..	..	..	..	21.10	15.85
Mineral matter	..	..	..	..	..	..	9.15	11.80

## Cellulose

Cellulose, in the purely chemical acceptance of the term, generally speaking, refers to the dominant homogenous organic substance which in the higher plants forms membranes and serves the purpose of partitions and cell-walls. Cellulose is represented by the general formula  $(C_6H_{10}O_5)_n$  and possesses the special chemical property of producing glucose on complete hydrolysis.

In wheat straw it is associated with substances called hemicellulose which include hexosans (galactans) and pentosans (arabans and xylans) which in turn become more easily hydrolysed than cellulose and on hydrolysis yield glucose, galactose, arabinose and, especially, xylose. Moreover, the cellulose of certain parts of the stem is encrusted with chemical substances of an entirely different kind, pectins and lignins which form the pecto- and ligno-celluloses. Straw also contains waxes, fatty substances, pigments and nitrogenous substances.

In the cell wall, cellulose is produced by the association of molecules of  $\beta$ -glucose placed end to end but grouped in pairs in molecules of cellobiose, and actually form, by spatial association, bundles which moreover are visible by means of the electron microscope. Amongst these bundles of cellulose fibrils are intercolated the associated polysaccharides whose chain length is shorter than that of cellulose, a feature which makes for their easier and more rapid extraction and hydrolysis.



Bishop and Adams (1950) tried to separate holocellulose from wheat straw by a treatment which consisted in soaking it in liquid anhydrous ammonia for 36 hours. According to them, the fractionation of holocellulose has always been empirical and the principal procedure described by O'Dwyer (1926) consisted in extracting the holocellulose by means of an alkali and precipitating the hemicellulose fraction by successive addition of acids and ethanol to the extracts.

Bishop and Adams used holocellulose from wheat straw after extracting the lignins by means of sodium chlorite. Without going into details of this new method of analysing the cellulose of wheat straw, it is worth noting that these authors obtained cellulose fractions more complete in holocellulose, pentosans, and uronic acid derivatives with acetyl and methoxyl radicles, and, as regards hemicelluloses, fractions which were more complete in d-xylose, l-arabinose, d-glucose, d-galactose and a hexouronic acid, exhibiting respectively the molecular proportions 40—7—1—2—4. They also isolated an uronic acid complex which resisted hydrolysis and was made up of d-xylose and monomethoxylgalactinuronic acid. Adams and Castagne (1951) studied more particularly the hemicelluloses of wheat straw. They were able to extract by hydrolysis d-xylose



which, with l-arabinose, predominates, and d-glucose and d-galactose in proportionately small amounts. They found, moreover, that all hydrolysates contained an acid-resistant complex which included d-xylose and an uronic acid which they tried to identify with monomethoxylgalacturonic acid.

To recapitulate, the upshot of these investigations is that chemical fractionation makes available from the constituents of the straw those sugars which Treschow showed were, in pure culture, the carbohydrate substances of choice for the cultivated mushroom.

It now remains necessary to ascertain if these microbial activities during composting are capable of bringing about cellulolysis and of liberating those simpler, and for the cultivated mushroom, very easily assimilable sugars. Our knowledge of these matters is very imperfect, and the chief reason for this may be the lack of exact information which we have concerning the mechanism of the breakdown of straw during composting. The virtual impossibility of being able to isolate intermediate breakdown products precludes any indication of the course followed by this degradation process.

In fermentation reactions which bring about the maturation of the compost the ideal state is a high temperature limit which coincides with maximum microbial activity. Allen (1950) studied the dynamic nature of thermophily. It seems, from his studies on bacteria isolated from manure between 55—65° C., that these bacteria have a maximum temperature limit of 65° C. and a minimum temperature limit of 25—45° C. according to the strain. His experimental studies on several thermophilic aerobic or facultatively aerobic spore-forming bacteria have shown that the capacity that these organisms show for multiplying and for metabolising at high temperatures is not absolutely due to the stability of the intrinsic structure of their proteins enabling them to resist extreme conditions, but is based on the active metabolism of these bacteria. When active metabolism is impossible they are no more resistant than mesophile forms. This author showed that, in the absence of food, thermophilic bacteria die at 55° C. as rapidly as other bacteria for the reason that their enzymatic systems are rapidly inactivated at this temperature. Thermophilic bacteria are able to live at high temperatures only because they are able to synthesize enzymes and other cell-constituents at a faster rate than they can be destroyed by heat. The maximum temperature is reached when thermal destruction of enzymes predominates over synthesis of enzymes. These bacteria have a temperature co-efficient for the synthesis of enzymes which lies at a higher level than that of mesophile bacteria.

The micro-organisms which are capable of disintegrating the straw of manures are numerous and varied. All, moreover, by contributing their cellular substance, either in autolysed form or as material used repeatedly by successive micro-organisms, contribute to the enrichment of the medium which is composed of that aggregate of amorphous substance which turns from brown to black and which, being difficult to define, is called humus. Now the yields from mushroom cultivation depend more on the course of the composting process than on the

initial fertility of the manure. We should therefore try to understand the activities of these organisms which intermingle in a succession of cycles which the grower actually controls by means of two factors, viz., the degree of humidity and the degree of ventilation of the manure heap which is undergoing composting.

## Fungi

The common fungi, species of *Mucor*, *Rhizopus* and *Oidium*, do not seem to be capable of growing on cellulose and have only an ephemeral existence, living for only a short time on the manure at the expense of the residual starch in the straw. Species of *Trichoderma*, *Penicillium* and *Aspergillus*, on the contrary, attack cellulose, but at a temperature only slightly above the normal. Reese (1951) showed that all members of the genus *Aspergillus* are capable of hydrolysing the 1—4 $\beta$  glucosidic links found in the cellulose chain. Thom and Raper (1945) considered that *Aspergillus fumigatus* grew well at 45° C. and even at 55° C. Amongst the higher fungi, some species of *Coprinus* grow on damp straw. The cultivated mushroom is also capable of producing a certain amount of growth on fresh uncomposted manure provided that the ammonia is liberated from it.

## Actinomycetes

The rôle of actinomycetes in the composting of manure has been for a long time underestimated and little work has been carried out concerning them. Waksman and his co-workers (Actinomycetes 1950) emphasized the importance of these organisms which seem to be able to decompose cellulose more or less rapidly, and some strains do so at high temperatures. At 60° C. their growth is so abundant that it can replace the whole microbial population and is visible to the naked eye as whitish masses occurring in the upper layer of the manure heap at the height of the composing process. Here is, in telling form, a table drawn up by Waksman (1950) regarding the influence of temperature on the development of micro-organisms in fermenting horse manure.

Incubation temperature °C.	Incubation period (days)	(per gram of moist compost)		
		Bacteria (millions)	Actinomycetes (millions)	Fungi (thousands)
Start	0 .. .. .	1,600	0.2	200
28	2 .. .. .	14,000*		0
	8 .. .. .	175*		
	21 .. .. .	85*		11,000
	39 .. .. .	50*		600
50	2 .. .. .	100*		
	5 .. .. .	850	150	
	8 .. .. .	1,000	1,000	
	21 .. .. .	few	14	2,000
	39 .. .. .	0	6.4	1,000
65	2 .. .. .	100		0
	5 .. .. .		2	0
	8 .. .. .		106	0
	21 .. .. .		2.5	0
	39 .. .. .		7.6	0
75	8 .. .. .	3.5	0	0
	21 .. .. .	2	0	0

\*including Actinomycetes



Fig. 1. Felt of actinomycetes coating the parenchymatous cell-walls of straw. Photomicrograph x 2000.



Fig. 2. Cocci more or less in chains surrounding straw particles. Photomicrograph x 2000.

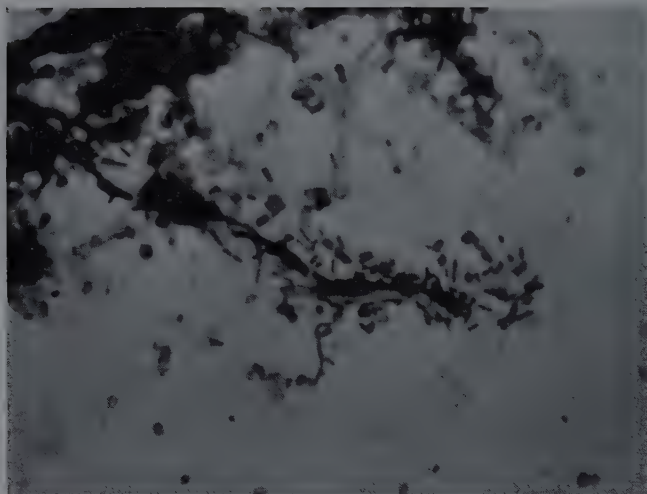


Fig. 3. Streptomycetes, bacilli and cocci along a cellulose fibre. Photomicrograph x 2000.

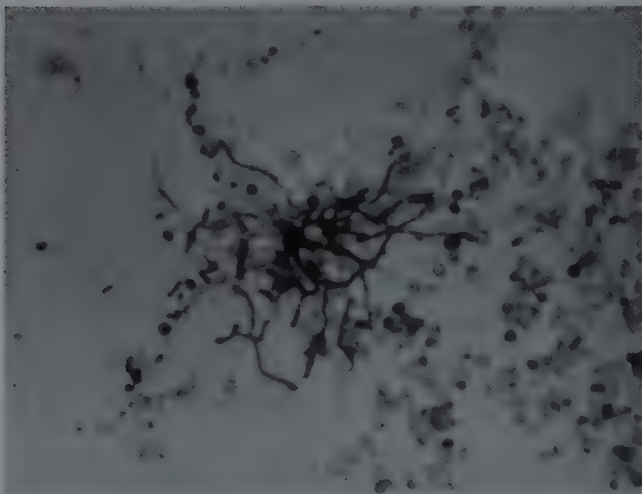


Fig. 4. Mixed population: actinomycetes and bacteria. Photomicrograph x 2000.  
Photomicrographs by André Sarazin.



Thermophilic actinomycetes are facultative thermophiles which can grow at temperatures between 50—60° C. and at 28° C. They are normally aerobic and belong to two genera, *Streptomyces* and *Micromonospora*. These genera are distinguished from each other by a difference in the formation of their spores which in the genus *Streptomyces* is by fragmentation of an aerial hypha from top to bottom, whereas in the genus *Micromonospora* the conidia are borne in bunches on special branches. Although, generally speaking, all Actinomycetes are Gram positive, some can be Gram negative at a temperature above 50° C.

These actinomycetes are capable of utilising a great variety of carbohydrates, not only simple sugars and starch but also hemicelluloses, xylans, and even lignicelluloses.

### **Bacteria**

In manure which is at the height of the composting process, living conditions are very different in different parts of the heap.

1. There is less and less oxygen towards the centre of the heap.
2. The pH limits are likewise variable, ranging from 9 during the period of ammonification to 5.4 in fermentations which generate organic acids.
3. Temperatures range from 20—70° C.

The bacteria are therefore more or less thermophilic aerobes, and besides, there is often no strict limit between these two modes of life.

According to Imsenecki and Solnzeva (1945), two groups can be distinguished: stenothermal, not developing at lower temperatures, and eurythermal, developing at these temperatures. As a result of rapid reproduction all these thermophiles die rapidly and become immediately autolysed or disintegrated. Ageing of cultures is rapid and aeration of the cultures accelerates reproduction in these aerobic thermophilic bacteria.

Low temperature cellulolytic thermophilic bacteria have been much studied as they are of more interest to Agriculture. For example, to quote the work of Brischot and Sylvestre (1951), the straw of manure buried in the soil disappeared very rapidly and was attacked by organisms which were capable of fixing both atmospheric and ammoniacal nitrogen. Fuller and Norman (1943) isolated six species of aerobic mesophiles belonging to the genus *Pseudomonas* which were able to decompose cellulose although able to utilise other carbohydrate substances. These bacteria make use first of all of xylan which has a beneficial influence. But composted manure is of no use for intensive mushroom growing unless the composting has taken place at high temperatures. For this reason, without denying the cellulolytic action of mesophilic bacteria which can act by initiating thermogenesis either at the commencement of the composting process or in the colder parts of the manure heap, it is plausible to concede that only the thermophilic bacteria are of considerable interest to the mushroom grower.

To sum up, the rôle of aerobic thermophilic bacteria, without being defined, seems to be that of breaking down straw to its end products, carbon dioxide and water, for, while at the same time they enrich the

mass with their protoplasm, they seem to bring about the total combustion of the straw by means of a drastic rise in temperature in the relatively well ventilated parts of the manure heap. After the progressive and ultimately total consumption of oxygen in this heap, anaerobiosis prevails and only the anaerobic thermophilic bacteria come into action. Besides, there is no sharp line of distinction between aerobiosis and anaerobiosis; a certain number of forms overlap and exercise their cellulolytic action both as aerobes and anaerobes. Pochon (1944) nevertheless considers that in order to avoid classifying as facultative organisms microbes whose entire biological cycle corresponds with that of anaerobes, these two groups should be contradistinguished: on the one hand, the functional aerobes, by means of whose fermentative metabolism oxycellulose is formed from cellulose, and on the other, the functional anaerobes which on the contrary degrade it down to the end products, fatty acids, both fixed and volatile, as well as gases. The nitrogen requirements of these anaerobic thermophiles are fairly exacting and more often than not they must be in the organic form. The dynamic temperatures vary from 40 to 68° C. and 70° C. with an optimum lying between 60 and 65° C. This group of bacteria is not well understood. The phenomena associated with them are complex, for cellulolysis and proteolysis and the synthesis of proteins and humus are all involved. Among these bacteria, those which have been well studied are few. According to Prevot they are: *Caduceus cellulose dissolvens*, *Terminosporus thermocellus*, *Plectridium* Sniezskoi, etc., whose optimum lies between 45 and 65° C. and whose products of cellulose fermentation are organic acids, ethyl alcohol and gaseous substances. An interesting fact was observed by Pochon (1951): certain strains would grow in pure culture only when stomach extract, acting as a growth substance, was present. McBee (1948) isolated two pure cultures of thermophilic bacteria which decomposed cellulose in manure, and studied their physiology. The products which he obtained from their activity were:—carbon dioxide, hydrogen ethyl alcohol, formic acid, acetic acid, lactic acid, succinic acid and glycerol. These products represent at least 70% of the fermented cellulose and he thinks that unidentified products were also formed. Cellobiose and glucose were formed as intermediate products.

By carefully blocking fermentation at intermediate stages by repeated additions of alcohol to the medium in which cellulolysis was taking place, Enebo (1949) was able to detect the formation of reducing sugars during this process. By this means he was able to isolate small quantities of cellobiose and glucose.

Pochon, Tchan, Wang and Augier (1949) tried to detect the mechanism of cellulolysis and found that precipitated cellulose did not, in a mixed microbial flora, give rise to the same microbial activity as that occurring on fibrous cellulose in the form, for instance, of filter paper, and that certain microbes were able to proliferate on the former but not on the latter.

Reese, Sier and Levinson (1950), working with pharmaceutical gels made of soluble cellulose, gave prominence to this dual behaviour and explained the histological breakdown of cellulose in two stages:—

- (a) The conversion of native cellulose into linear chains of anhydro-glucose.
- (b) Following on this the hydrolysis of the 1—4  $\beta$ -glucosidic link to form soluble sugars.

The *celluloses* are complexes consisting of two categories of enzymes:—A group of enzymes C1 which break the linkages of the fibrous cellulose, and a group of enzymes Cx which degrade these smaller chains into glucose. Those microbes which bear only Cx enzymes, and which are the more numerous, are able to use only precipitated cellulose, in other words cellulose which is not fibrous or only slightly polymerised. Only those microbes which are equipped with C1 and Cx, and which form a much smaller number, are able to act on fibrous cellulose. These are the real cellulolytic microbes (Pochon 1951).

*Hemicelluloses*, as previously remarked, are attacked more easily; they are often accompanied by gums and pectic substances. Numerous micro-organisms seem to be able to attack them, but no accurate work concerning them has been carried out. Now, we have already noted the great significance of these substances from the point of view of the cultivated mushroom, nevertheless it is difficult to say whether it is the hemicellulose derived from the straw or that synthesized by enzymes, viz., xylose, arabinose, glucose and galactose, which is consumed by the cultivated mushroom.

*Pectocelluloses* are disintegrated during the retting of flax and this subject has been much studied owing to its great interest to the textile industry. On the other hand, nothing has been done as regards these substances in connection with the composting of manures. Nevertheless, these substances which form the cementing material between the cells and whose disappearance favours the absorptive quality of the straw, also produce on hydrolysis sugars which can be assimilated by the cultivated mushroom. Indeed, they are for the most part arabans and galactans associated with a polygalacturonide.

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THE HAMPSHIRE GUANO CO. LTD.

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I have been asked . . . . .

## ABOUT PICKING

By Dr. R. L. EDWARDS

As this is still the holiday season I propose this month to provide some material and let you do the thinking—and the arguing when you get together!

One of the things that immediately struck me when I was first introduced to mushroom growing was the relatively enormous increase in the weight of a mushroom from one day to the next, and the great potential advantage of picking always at the maximum weight.

We made some observations on this point at Yaxley, by measuring the diameter of growing mushrooms daily on the beds and correlating these with the measurements and weight of mushrooms picked at various stages of growth. We found that the mushrooms continued to increase in weight up to the "flat" stage, Flats being heavier than Cups or Buttons of corresponding size, i.e., the Buttons and Cups which would have grown to the size of these particular Flats. Incidentally we found that on the average they doubled their weight every 24 hours. Looking back on that work I am not sure whether we took enough account of variations in the length of stalk. Stalks were trimmed in accordance with current commercial practice, before weighing of course, and I think this meant that both Cups and Flats had about the same length of stalk measured from the gills. Closed Cups would have considerably less visible stalk below the veil.

It appeared therefore that a substantial increase in yield might be obtained by leaving all mushrooms to open before picking, though we had some mental reservations about this, thinking that the result might be earlier exhaustion of the bed without any increase in the total yield.

At the next stage we picked half of the beds for closed mushrooms while the other half were always left to open. We were surprised and disappointed to find no appreciable difference in the yield at any time.

We then tried picking three grades, Buttons, Cups and Flats, from separate groups of beds treated similarly in all other respects. This time we found that the Buttons were a little behind the Cups and Flats for ten weeks: then the Buttons continued to crop better as the Cups and Flats tailed off and there was no appreciable difference in the final yield, though this equalisation was completed after most commercial growers would have stopped picking and turned their beds out.

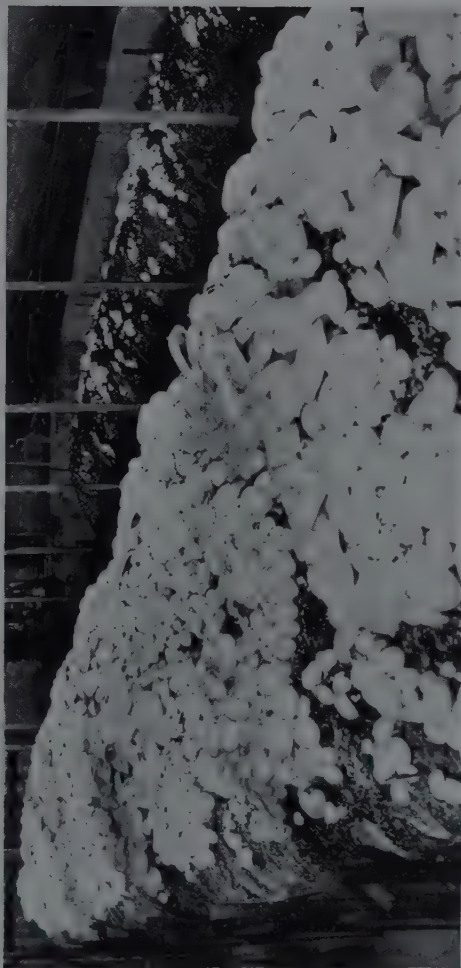
All this work was done several years ago and I rather have the impression that there is a tendency now to trim the stalks shorter on Flats than we did then, which would make them a worse proposition.

There is another and sometimes very big complication. The prices of Buttons, Cups and Flats are often not the same in any one market and individual markets differ in their preferences. I think it is common experience in the Midlands and in many local sales to greengrocers

YOU  
can be  
Sure of

Mount

Mushroom  
Spawn



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elsewhere, that Flats of good size, over three inches in diameter, are most popular, whereas there is a very good market in London for quite small tight Buttons.

When the price difference for such a preferred grade may be 6d. or 1/- per lb. or even more, this can outweigh any difference in yield and, of course, for these markets it is worth grading and packing to suit their demands. On the other hand there are some smaller markets which are equally happy with mushrooms at all stages of growth and never return any difference in price for Buttons, Cups, Flats or Mixed (of reasonable quality of course); it is these markets which justify the question "Why grade?" so often asked by growers who do not want the bother.

There seems to be considerable scope for a study of methods of picking, grading and packing, to reduce labour to the minimum. Is it better, for instance, to trim stalks and/or grade while picking, or to do one or both of these as a separate operation in the packing shed? I don't know the answers—yet, except in the case when there are hordes of small mushrooms. They must certainly be handled as little as possible which means packing them ungraded on the spot as they are picked.

Several years ago I had figures for two farms which showed respectively 15 lb. and 30 lb. per man-hour for picking and for cleaning the beds, and 20 lb. and 30 lb. per man-hour for packing (actually they were woman-hours). Even allowing for the differences between farms, buildings, etc., and for the fact that little cleaning was done on the second farm, the difference between these two examples could amount to over £1,000 p.a., on a big farm.

There indeed is food for thought!

---

## SOMETHING NEW IN SOIL STERILIZING?

Writing from Helensburgh, New South Wales, Australia, Mr. M. Lawson of Messrs. Dearing and Lawson, says that for the last 12 months they have been using Methyl Bromide\* gas for sterilizing their casing soil (top-soil), and have found it quite satisfactory.

The soil is placed in a 6' × 6' × 3' bin which is then covered with a plastic gas-tight sheet. The Methyl Bromide arrives in small cans. The cans are opened by a patent device and the liquid, which gasifies when a little heat is applied, is piped off into the plastic envelope covering the soil bin. In 24 hours the sheet is removed and a further 48 hours is allowed to elapse for the gas to clear before casing is begun. Adds Mr. Lawson: "We shall be very interested to know if this technique is employed overseas."

A further note on labour and wages conditions in Australia states that the basic rural wage is £13 for a 44 hour week, "which," comments Mr. Lawson, "in practice, because of labour shortages, works out at £16 for a 40 hour week. With mushrooms at an average market price of 5/- per lb. we must become efficient or perish," he concludes.

\*Note: According to Dr. R. L. Edwards, Methyl Bromide is used mainly as a fumigant for cereal grains in warehouses and he has not heard of it being used to sterilize mushroom casing soil.—Ed.

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FOR FURTHER PARTICULARS

WRITE TO

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EST. 1860

**WORTHING**

**SUSSEX**

# LB. PER SQ. FT. IS SO MISLEADING—2

By E. PALFREY

The mushroom grower, unlike the general farmer, is not bound to one crop a year. He must not, therefore, allow himself to assume the farmer's attitude—that the size of the crop is the only thing that matters. Good production is a good crop in good time.

Different productions arising from different cultural methods can be compared, as was shown in the first article. But different crops, by which I shall mean yields and their picking times, will always be compared profitably, and here let us pose the question through our eavesdropping.

*Smith:* "Look at this crop— $2\frac{1}{4}$  lb. What accounted for that, when your average is  $1\frac{3}{4}$ ?"

*Robinson:* "Well, I'm not certain how much of that we should say arose from the extra week and a half we gave it. We couldn't get our manure when we wanted; there wasn't any disease, so we left it in."

*Smith:* "You say you crop for 7 weeks—but look at these figures:  $7\frac{1}{2}$ , 5, 6, 8,  $8\frac{1}{2}$ , 7, 7, 6, 8! However can you compare the yields? In fact, how can you compare the different treatments you give the crops?"

*Robinson:* "I know. That's just one *more* factor to make the whole business more difficult."

Let's remove that factor. We want an index which is little or not affected by the moment at which we turn out the house. One evident way is to compare all the crops after, say, 5 weeks, when we know we never turn out before this. But inevitably this loses information, because we are not using the final yield. The following, although it does not entirely eliminate the time factor, minimises it, and enables us to use the entire crop result.

**The Crop Index.** This is defined as—

Total crop for 1,000 sq. ft.

number of days picking + X days

where X is to be determined.

**The determination of X.**

- (1) Draw the cumulative yield graph of a representative number of crops, say, 20.
- (2) Draw a straight line through the last week of plotted points for each.
- (3) Where the line cuts the time axis, note the number of days before picking.
- (4) Then X is the average of these values.

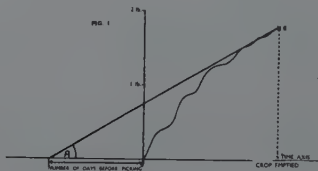
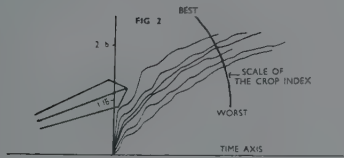


Figure 1 shows what is to be done for each crop.



# The Characteristics of the Crop Index

- (1) It makes use of the final yield.
- (2) A crop ideally turned out at, say, 8 weeks, if turned out a week earlier or later, will lead to a Crop Index only a little changed. Thus, in Figure 1, as the Crop Index is a measure of the angle A, it is seen to vary only a little with the movement of E along the curve.
- (3) The scale of the Crop Index takes into account the two characteristics of a crop—yield and time, as seen in Figure 2.\*
- (4) Finally, if we draw a number of crops, we have this:

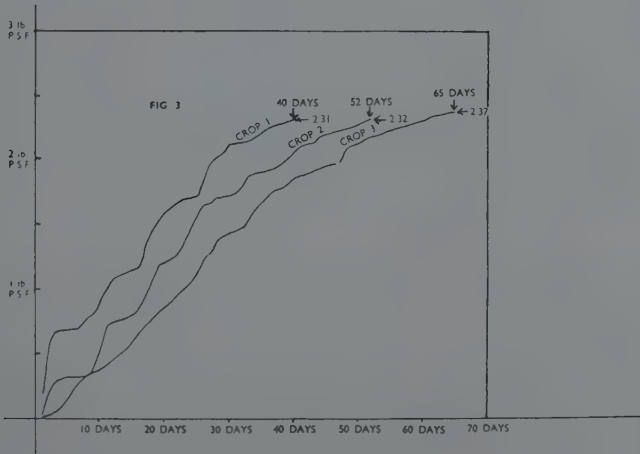


If we look along the direction of the arrow we immediately separate out the crops, and we can compare them easily. This is the “angle” from which the Crop Index is defined.

## Some Examples:

I have chosen three crops which demonstrate the value of the Crop Index. They are commercially grown crops and have been turned out at different times.

Here they are compared graphically:



It is quite evident that the best crop is Crop 1 and the worst, Crop 3. And here is the assessment made of each on the grounds of lb. per sq. ft. and the Crop Index. (I have used 60 as a value for X):

Crop No.	Lb. per sq. ft.	Crop Index
1	2.31	23.1
2	2.32	20.7
3	2.37	19.0

Here the Crop Index clearly shows Crop 1 to be the best and Crop 3 to be the worst, while lb. per sq. ft. gives an entirely misleading impression.

**In conclusion**, I would say that when the time of cropping varies, on its own, lb. per sq. ft. obscures many comparisons and is just confusing. For a little trouble we can look at the crops in a perspective which is more true.

And we may very well *learn something!*

\*(The scale is shown as a single line but it is in fact made up of an infinite number of lines concentric about the point X days before picking on the Time Axis.)

## INDIVIDUAL PUBLICITY



Major A. L. A. Dredge of Coombe Bank Gardens, Sundridge, Kent, took a small stand at his local horticultural show a short time ago. In next month's Bulletin he will describe his experiences. Maj. Dredge is pictured herewith, with his exhibit.

## Latest Publicity Fund Contributions

*C. Snowdon & Co. Ltd., Castlefold Market Sheffield (Salesmen)	£	s.	d.
	1	14	3
*Reuben Levy Ltd., 46 London Fruit Exchange, Spitalfields (Salesmen)		19	10
G. E. Redgewell, Esq., Morecambe, Lancs.	1	1	0
*Fred. Hall & Sons, Ltd., Station Street, Middlesbro' (Salesmen)	9	8	9

\*Previous contributions already acknowledged

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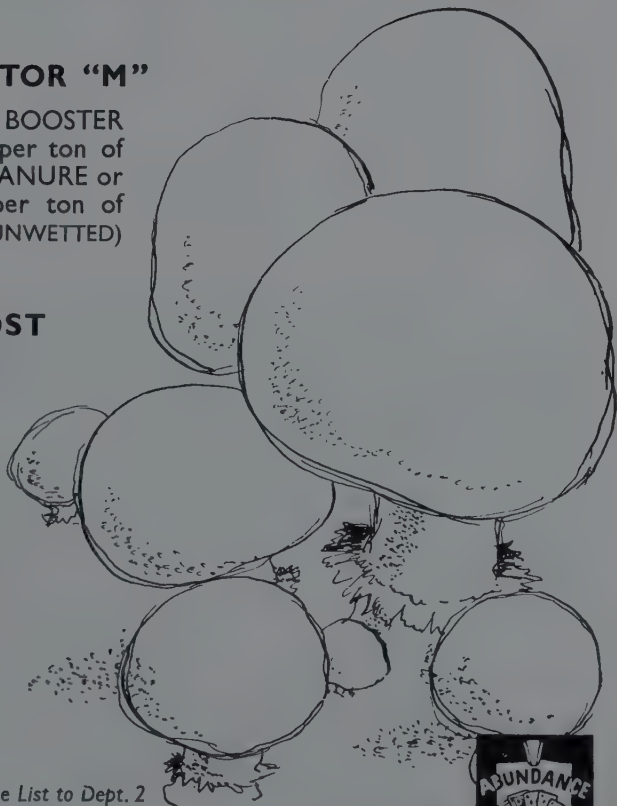
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**1954**

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\* *Final Report of the  
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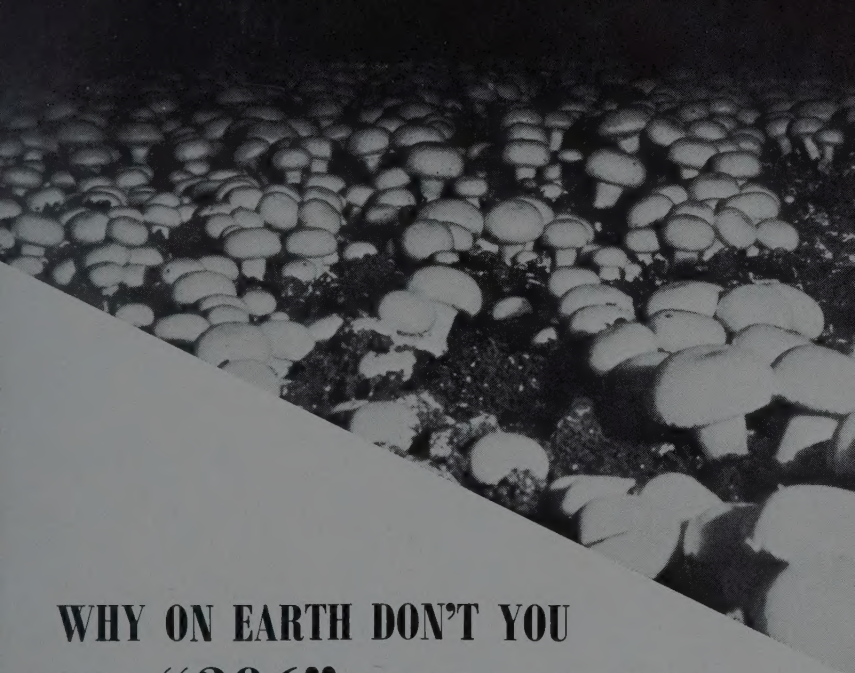
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